**ANSWERS: Explaining Polarity of molecules**

***Key points to consider for an Excellence grade are...***

***Does the molecule***

***1) contain polar bond(s), you must refer to a difference in electronegativity between the relevant atoms***

***2) contain lone pair(s) around the central atom***

***3) have a symmetrical shape***

***4) whether the polar covalent bonds (aka dipoles) cancel***

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| The C-Cl bond is polar due to the difference in electronegativity between C and Cl. The C-Cl bonds are more polar than the C-H bond as the electronegativity of CI is greater than the electronegativity of C and H. The bonds are arranged symmetrically in tetrahedral positions around the C atom.  CHCl3 and CH2Cl2 have four regions of electron density around the central C atom. These are all bonding pairs of electrons so the shape of both molecules is tetrahedral.  Because the bonds are arranged in tetrahedral positions and the C–Cl bonds are polar, both **CH3Cl** and **CH2Cl2** are polar molecules. | | In **H2S,** the polar bonds are arranged  asymmetrically around the central atom in a bent shape as there are two lone pairs of electrons on the central atom. The bond dipoles do not cancel so the molecule is polar.  **CO2** has non-polar molecules. The C−O bonds of CO2 are polar due to the differing electronegativities of C and O atoms. However, as there are only 2 electron repulsions about the central C atom, the polar bonds are symmetrical about the C atom / linear shape, and the effect of these polar bonds/bond dipoles is cancelled, so that the molecule is nonpolar. | | |
| Non-polar molecules arise when there are no polar bonds present in the molecule or the spread of charge is even. Molecules are polar if there is an uneven spread of charge over the molecule.  In **CH3Cl**, the polarity of the C–H bonds and the C–Cl bonds is different; due to differences in electronegativity (the C–Cl bonds are more polar). Therefore the charges are not spread evenly around the central C atom / the dipoles do not cancel, and the molecule is polar overall.  In **NH3**, the N–H bonds are polar due to differences in electronegativity / dipoles of N and H. The three polar N–H bonds are not spread symmetrically around the trigonal pyramid shaped molecule, due to the lone pair of electrons, therefore the molecule is polar.  In **CCl4**, the C–Cl bonds are polar, due to differences in electronegativity of C and Cl. However, four C–Cl bonds are arranged symmetrically in a tetrahedral  shape, and the charges are spread evenly, resulting in a non-polar molecule. | | | The molecule **CF4** has 4 electron repulsions around the central C atom, which are all bonding sets, so the shape is tetrahedral. The C-F bond is polar due to the difference in electronegativity between C and F. The polar bonds are arranged symmetrically around the central atom, so the bond dipoles cancel and the molecule is non-polar.  The **Cl2O (or OCl2)**molecule has 4 electron repulsions around the central atom, which gives the molecule a basic tetrahedral shape. Two are bonding sets and two are non-bonding sets, so the molecule has a bent shape. Cl2Oalsocontains polar bonds.  The bonds are polar as the atoms in the bonds have different electronegativity values. In Cl2O,the polar bonds are arranged asymmetrically around the central atom in a bent shape as there are two lone pair of electrons on the central atom. The bond dipoles do not cancel and the molecule is polar. | |
| The **COCl2** molecule has 3 areas ofelectron repulsion around the central C atom, so the shape is trigonal planar. Both C–Cl bonds are polar, due to the difference in electronegativity of C and Cl. The C=O bond is also polar, due to the difference in electronegativity of C and O.  Even though the shape is trigonal planar, the molecule is asymmetrical, as the electronegativity difference of the three bonds is not the same. Therefore the effects of these polar bonds are not cancelled and the molecule is polar overall. | | | | **SO2** has polar molecules. The S−O bonds of SO2 are polar due to the differing electronegativities of S and O. There are 3 electron repulsions about the central S atom (trigonal planar), however, the lone pair of electrons on the S atom causes the S−O bonds to occupy a bent or V shape around the central S. Therefore the effect of these polar bonds /bond dipoles is not cancelled, so that the molecule is polar. |
| The N−Cl bond in **NCl3** is polar due to the difference in electronegativity of Cl and N atoms. The trigonal pyramid arrangement of the three N−Cl bonds around the N atom is asymmetrical. The lone pair of electrons on the N atom causes the asymmetry. The effect of the polar bonds is not cancelled, making the molecule polar. | **SiH4** is non-polar, The Si–H bonds are polar, because of differing electronegativities of Si and H. However, as there are 4 electron repulsions around the central Si atom, the polar bonds are arranged symmetrically around the central atom / tetrahedral shape. The net effect is that the bond dipoles cancel, therefore the molecule is non-polar. | | | |

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